L3 and M1 internships for the Computer Science Department of the ENS Paris-Saclay

This document aims to help the L3 and M1 students during their internship, their tutor at *lsv* and the examination boards.

Contents

1 What is the purpose of an internship ?

Doing an internship is a way to:

- discover academic research,
- discover a domain or deepen one's understanding of it,
- develop a network of contacts;
- discover new working environments and methods, as well as linguistic and cultural elements.

All these aspects, even in the rare event when the experience is a negative one, may help you choose a subject and a supervisor for your PhD thesis.

2 Searching for an internship

Tutors help you during the search for your internship. The dialog begins with an individual interview. Tell them about your hopes/ideas, your next steps and your contacts. They may then suggest some possible supervisors, help you look for them on the internet, or redirect you to another researcher of the LSV, who may have better knowledge of the domain you are interested in.

2.1 The first email to a potential supervisor

Once you have identified a potential supervisor, you can write them a first email, either as a reaction to an internship proposal found on their web page, or as a spontaneous application, in which case a specific proposal can emerge from your discussions.

The fist email is very important, especially when applying for internships abroad, where the french academic system may not be well-known.

Your contact may receive many internship applications every year. A clear, personalised, but not too long email is more likely to be read carefully.

Call the person by their name (e.g Dear Professor Ward), show briefly that you read their web page. For instance, you may refer to the place where the potential internship is supposed to take place.

Especially if you are looking for an internship abroad, explain that the school trains future researchers, and that the department teaches *theoretical* computer science. Always mention the curriculum year your are in (note that L3 and M1 are french acronyms).

If you contact someone as a reaction to an internship proposal found on their web page, you may read the abstracts of some publications mentioned in the subject : the language elements can help you to write your email.

For a spontaneous application, describe what type of subjects you are interested in (knowing that it is normal not to have a very clear idea about it - do your best).

In any case, mention the classes you attend, your previous internships, your personal readings if it concerns the domain of your potential supervisor, or closely related domains.

You can also attach a résumé to the email, but it is less likely to be read than the rest of the email.

2.2 the internship subject

A complete internship subject should mention or imply

- the possible dates for the internship;
- the list of the official and/or effective supervisors (including the PhD. students);
- the scientific context;
- a scientific subject;
- a description of the prerequisites and of the bibliography;
- a description of the internship in case of a lockdown.

The subject must have scientific content, either purely theoretical, or with an experimental component. The experimental component cannot be reduced to only programming : it must include experiments and an aggregation of collected data by statistical quantities and interpretations.

Bibliographic studies and getting the prerequisites to do your internship shouldn't take more than a small portion of it : roughly for an end of license internship, half of your internship time, a third for a M1 short internship, a fourth for a M1 long internship.

If the internship of your dreams doesn't come with a plan to do it remotely, you should seriously think about a plan B.

2.3 Deadlines and other approximate quantities depending on the internship type

L3 internship

- Duration: at least six weeks, usually less than eight.
- Beginning: after the end of the courses, late May or early June.
- End: before mid August.
- location: out of Île-de-France, with possible exceptions for foreign students or for medical reasons.
- Meeting with your tutor: from November onwards, not later than January.
- Applications: from December onwards, not later than February.
- Agreement in principle: not later than March. (Earlier for countries requiring heavy administrative tasks, such as the USA or the UK.)
- Agreement request: not later than April, as the DSVE is very busy in May.

Short M1 internship

- Duration: two month and a half
- Beginning: after the end of the courses and exams, late May or early June
- End: During august, at least one week before the end of August if possible
- Location: Outside of France, except for non-French if wanted or for a medical reason
- Discussing with you tutor: starting from October, not later than December
- Applications: not later than February
- Agreement in principle: not later than March.
- Agreement request: not later than April as the DSVE is very busy in May.

Long M1 internship

- Duration: five months.
- Beginning: between late January and early March.
- End: before mid August.
- Location: abroad, with possible exceptions for foreign students or for medical reasons.
- Meeting with your tutor: not later than October.
- Application: from October onwards, not later than December.

- Agreement in principle: not later than January (for an internship beginning in March).
- Agreement request: not later than February (for an internship beginning in March).

2.4 Logistics

When talks have sufficiently progressed, you can ask for logistical information.

Status and internship agreement Depending on your status at the school, you may have different status in the research team.

Usual privileges Will you have a chair and a desk, a computer, an access to the restaurant and to the library?

Potentially Allowance, housing, transport. Civil servants cannot ask for an additional pay. Others can ask the host organisation, even for an internship shorter than two months. Some countries will grant you the minimum wage, even for a L3 internship.

There are several grants for international mobility. The SRI (service for international relations) can give you information about them.

Establishing an internship agreement After an agreement in principle with your supervisor, you need to fill the internship subject and administrative informations on the *serveur pédagogique*, after a confirmation from your supervisor.

The subject will then be validated by the head of the year, usually in the next two weeks.

You will then fill in the internship agreement request, for which the form is on the *serveur pédagogique*. You will then have it signed by your tutor and the director of the department, who will then transmit it to the DSVE and will send the agreement to the supervisor. From this point the intern and the department will not have anything to do.

Number constraints In each class, there should not be more than two interns in the same team, and no more than three in the same laboratory. Some exceptions are possible for a huge team or laboratory. In order to avoid any conflict, students usually share between themselves information about their internship locations as they get it. These constraints might be eased for remote internships.

3 During the internship

Follow up of the intern by the tutor One or two weeks after the beginning and in the middle of the internship, the student must send an email to the tutor, either to say briefly that everything is all right or to describe any difficulty encountered. During these same periods, the tutor will send an email to ask for some feedback. The head of year may remind the tutors to do so.

Emails from the tutor or the intern may include the following topics, and others depending on the internship conditions:

1. Is everything going as planned on the logistical level?
2. Have the supervisors changed?
3. When has the internship started?
4. How many times has the intern talked with the supervisor?
5. Do you feel you understand the internship subject and what is expected from you?

Supervision Some supervisors frequently ask interns if everything is all right and if they have questions, while some others wait for the interns to come to them for questions. Do not hesitate to ask your supervisor how they prefer to interact, the regularity and the format.

In case of an almost nonexistent interaction, contact your tutor quickly.

Colleagues and laboratory life

- Attending the talks of the host team is likely to help you understand better the scientific context of your internship.
- Attending the talks of the host laboratory is likely to help you discover other fields and help you build your culture.

In case of an invalidated hypothesis or of a refuted conjecture Negative experimental results also are a kind of results. A counter-example to a theoretical conjecture is also a theoretical result. In both cases, the result is sometimes judged weaker/uninteresting, and it can be wise either to fall back on an easier question or to deepen bibliographic work.

Writing the internship report Start writing early enough, as it takes a large amount of time and you will benefit from direct feedback from your supervisors. Few supervisors will give you detailed feedback by email, as it takes time to write it.

4 Internship assessment

Four items will be taken into account to evaluate the success of the internship. These items are listed here (roughly in chronological order).

- Assessment by the supervisor.
- The technical contribution of the internship.
- The internship report.
- The internship defense.

The technical contribution will be deduced from the three other items. Note that the scientific contribution of the internship is not only made of the technical contribution, but also from the internship report and the defense.

The next subsections will detail the four items. It is obvious that more maturity is expected from the M1 than from the L3, a more significant contribution for a longer internship etc.

4.1 Assessment by the supervisors

The interns must ensure that the supervisors send their evaluation by email to the head of the year and to the president of the jury at least 48 hours before the defense. Be careful: it is not the same as the second evaluation that you have to mail to the *service de la scolarité*, and which is useless for the department.

The department asks supervisors to give a mark among A (excellent), B (very good), C (good), D (adequate), E (inadequate), $\perp$ (irrelevant) to each of the following items. Each mark may be complemented by details or examples.

- Knowledge at the beginning of the internship.
- Knowledge acquisition during the internship.
- Interactivity with the supervisors.
- Pertinence of the questions.
- Pertinence of the answers.
- Initiatives and reactivity.
- Technical contribution.
- Regular writing of the report during the internship.
- Finishing a first version of the report in time.
- Enthusiasm, participation in the activities of the laboratory.
- Anything else.
- **Global assessment of the internship**.

4.2 Technical contribution of the internship

The technical contribution can either be purely theoretical or experimental with theoretical contents. Several possible aspects of the contribution are listed here.

Theoretical contribution:

- Solving a question asked by the supervisor, introduction of a question (caused by solving another question).
- Introduction of concepts in order to ask or solve a question.
- Proof of a new result; simplified proof of a known result; corrected proof of an existing attempt in the literature.
- Counter-example for a conjecture; simplifying a known counter-example.
- Finding a quicker or simpler algorithm, or one with better properties than the existing ones.

- Identifying the results in a field which can be applied in another field; translating the formalism in order to apply them.

Experimental contribution:

- Defining the objectives of the experiment: question asked, tested hypothesis.
- Definition of the samples: raw data, benchmarks.
- Designing or setting up an experimental protocol, carrying out the experiment.
- Designing or improving software as part of an experiment.
- Presenting results through statistics.
- Interpreting the results and critically evaluating the extent of their validity.

4.3 Internship report

The internship report is a compiled LaTeX document and reproduces the internship subject present on the *serveur pédagogique*. If the subject is partially different from the initial subject, explain briefly in which way and why.

You are writing your report for someone who has a knowledge basis in fundamental computer science but who does not know anything about your internship subject. Even if there are experts in the field at the LSV, availability constraints are so that they may not be the ones reading your report.

The main objective of the report is to explain clearly the technical contribution of the internship. More precisely, the report must present the scientific context of the internship, present the technical contribution of the internship, then evaluate it in the context.

To some smaller extent, the report will have to contain some meta information to help the jury understand the progression of the internship.

The four criteria are summed up below, in more details. Some examples and recommendations follow.

Assessment criteria for the internship report

1. Clarity (as perceived by the reader).
2. Pertinence and completeness (as perceived by the reader) of the presentation of the scientific context.
3. Maturity (as perceived by the reader) of the evaluation by the intern of their own technical contribution.
4. Presence of meta information.

Clarity Clarity is essential in order to convey the contents and identify the technical contribution of the internship: the efforts to clarify a report can be made at the local level (sentences, examples) and the global level (organisation of the report, keeping the same example throughout the report).

- Visual clarity: LaTeX parameters, figures (which are very much appreciated).
- Language clarity: grammar, spelling, style.
- Mathematical clarity: **correction**, legibility, simplicity.
- Conceptual clarity: examples, intuitions, explanation of the concepts in natural language as well as in mathematical language.
- Organisational clarity: report structure, introduction in particular; element introduction order; summary/abstract; main examples.

Scientific context The reports presents the main aspects of a scientific field, and the subfield to which the contribution belongs in more details. Several fundamental aspects of a subfield are listed below.

- The fundamental question: solved (founding results) or still open (research directions).
- The fundamental concepts: generic or specific to the field; necessary to ask questions, or only useful to answer them.
- Motivations: practical (engineering), purely theoretical (from the field for itself), hybrid (from the field to another).
- Most recent results: are they significant or anecdotal?
- State of the art, "history of the art", bibliography.

Self-evaluation of your contribution The evaluation explains how your contribution integrates into the (sub)field and improves it. This evaluation is thus an interface. A few positive aspects of a contribution are laid out below. Keep in mind that an interesting technical contribution may quite often have negative aspects, which should be mentioned as well for the sake of completeness.

- Quantitative comparison:
  - An algorithm with improved complexity: specify the complexity class of either algorithm, and, ideally, a worst-case example for the former algorithm, so the two can be clearly distinguished.
  - A faster algorithm on some relevant benchmark: specify the benchmark used, as well as alternative benchmarks and why those were not used. Give clear data along with units of measurement.
  - A shorter proof: a proof can be said to be somewhat, or much, shorter than another one after their lengths have been compared objectively, i.e. written out in the same LaTeX style and at the same level of detail.

- Qualitative comparison:
  - A more modular algorithm: explicit its structure, possibly with the help of a diagram.
  - A more intuitive proof: explain the intuition.
  - More algebraic and composable concepts: this should show through to a degree in the way they are used, in additional lemmas or in examples.
- A more general result:
  - Is the special case used in the proof of the general case? If not, does the general proof adapt the technique from the former proof or does it use a different, or even innovative technique?
  - New, weaker hypotheses: explain clearly in what way they are indeed weaker; evaluate the significance of the new cases taken into account.
  - A new, stronger conclusion: explain clearly in what way it is indeed stronger; evaluate the significance of the extra properties.
- A reasonable restriction of the general problem to a special case.
  - An interesting special case: explain why.
  - A useful special case for applications: give an example of one (or several) such application(s).
  - A useful special case to develop an intuition: explain the intuition.
  - A useful special case for simplifying proofs: compare the lengths, structures and concepts used.
- Pathway into a new subfield relevant to the larger field.
  - A foundational result: does it answer an open question? Can it simplify existing proofs, make certain things clearer?
  - A new question: why hadn't the question been asked yet?
- Reducing collective effort:
  - A counterexample which shows a research direction is a dead end: what previous effort had the community made in that direction?
  - Translation of a previous formalism, thereby showing how results from one field apply to another field: what communities will now be able to use the translated results?

Meta-information (not crucial, but helpful)

- Give a rough estimation of the time and effort put into each of the activities in the internship, for instance as percentages.
- Possibly mention what difficulties you encountered and how you overcame them.
- For programming activities, you may include the code as an appendix if it is very short (two pages at most), or specify the number of lines and procedures, the size of the file and the libraries used.
- Possibly mention what lab activities you have taken part in.

The abstract Your report should open with an abstract, about one page long. Of course, this abstract will be redundant with the introduction and conclusion of the report. The main points you should pay attention to when writing the abstract are listed below.

- The general context
- The problem at hand
- The contribution put forward
- The scope and limits of the contribution
- The summary and perspectives

A whimsical (and much shortened) example of an internship report

1. Technical contribution: a new algorithm to compute the whatchamacallit in finite oriented graphs with uniformly bounded degree.
2. General scientific context:
    - The concept of a whatchamacallit was introduced in 1955 for non-oriented graphs. In this setting, a simple algorithm to compute the whatchamacallit. The notion of a whatchamacallit is useful in statistical mechanics and political science.
    - Note that a similar notion had been defined by Leibniz before sinking into oblivion.
3. Specific scientific context:
    - In the 1990's, the computer science community expanded the notion of a whatchamacallit to oriented graphs to apply it to the Internet.
    - A first algorithm, simple but not primitive-recursive, was published in 1992.
    - A quintuply exponential algorithm was conceived in 2011. It combines algebraic and probabilistic approaches.
4. Evaluation of the technical contribution:

- Graphs with uniformly bounded degree form an important class of graphs. Indeed, experiments show that most of the nodes in an expanding network keep a relatively low degree.
- My algorithm is only triply exponential. On one hand, it uses an extra trick which makes the proof of complexity slightly harder; on the other hand, it doesn't use the probabilistic technique of the previous algorithm, which helps in simplifying the proof.
- Note that the trick is only possible in graphs with uniformly bounded degree. However, I do not know whether probabilistic techniques could lead to a twice exponential algorithm.
- I haven't had time to program my algorithm.

5. Metainformation:

   - General reading 10%, reading a particular article 15%, looking for an algorithm 10%, looking for an idea of the proof 10%, looking for good definitions for the proof 20%, writing the report 25%, taking part in lab activities 10%.
   - I spent 15 days without finding a proof, then I decided to focus temporarily on a simple special case. I solved it in one day, then two days later I found the proof for the general case.
   - I attended a third of the lab seminars and three quarters of the working groups of the host team. I attended one thesis defense and I liked the drinks that followed.

Writing stages

- A precise submission deadline will be given. Submit it before that date.
- Very early on, start writing a LaTeX draft of your report.
- Write out each definition, theorem, proof as soon as possible. Read them again a few days or weeks later. You will probably be led to modify them, which is expected.
- Ask your supervisors to comment on parts of your report early, especially the introduction. Then, rewrite them and take their suggestions into account.
- Your supervisors will probably have time to comment on your final report orally when you are on site (or during a video conference), but not later, in writing or while they're on holidays.

4.4 Intership defense

Depending on the evolution of the sanitary crisis, the defenses can take different forms: a classic defense, a videoconference or a recorded video. Broadly speaking, the advice given here is applicable in all of these tree cases. The text will be adjusted and specified, depending on the situation.

In any case, make sure to rehearse, either alone, or in front of fellow students, or ideally with your tutor.

Format

- At most 25 minutes of presentation.
- 5 to 20 minutes of questions, in average 10 minutes.
- Short explanations may be asked during the presentation, so that the important points are well understood.

Evaluation and recommandations The internship defense is a summary in the broad sense of the internship report. The expected information is similar; the evaluation criteria will also be similar. Here we will focus on the differences between the defense and the report.

- The tone, pace and enthusiasm help to convey the content.
- Prepare 15 to 20 slides for a classic defense. (More or less in certain cases.)
- Do not put too much text on the slides, otherwise the audience will read it instead of listening to you.
- Keep in mind that it is hard to understand and retain more than five simple definitions (four, for my part) in less than ten minutes.
- The audience and the jury do not know the subject of the internship, even if one member of the jury read the report.
- Some technical details may not be mentioned if they are not essential to understand the contribution.
- One could possibly focus on a simplified (but not simplistic) version of the result.
- One could detail a part of the report, and only mention the rest.
- One could emphasise the examples, the figures (colorful ones, but also with variable stroke width, as 5% of the male population is color blind)
- If there is one, the question and answer session is an important moment, not only for clarification, but also as a conversation between (future) researchers. Try to understand well the questions, which may be rephrased by one or another party, and answer them honestly.

5 Summary of the jury's evaluation

The department asks the reviewers and the jury to give a mark among A (excellent), B (very good), C (good), D (reasonable), E (insufficient), $\perp$ (irrelevant) to each of the following points, then to the whole internship, taking into account the evaluation of the supervisor. Of course, the jury expects a greater maturity from the M1 students than from the L3 students, and a greater contribution during a long internship, etc.

- The technical contribution

- The internship report (exclusive of the technical contribution)
    1. Clarity.
    2. Relevance and completeness of the presentation of the scientific context.
    3. Maturity of the evaluation by the intern of their own technical contribution.
    4. Presence of metainformation.
    5. The report as a whole.
- The defense (exclusive of the technical contribution)
    1. Clarity.
    2. Scientific context.
    3. Maturity of self-evaluation.
    4. Presence of meta-information.
    5. The defense as a whole.